Multi-Beam FITS (MBFITS) Raw Data Format Summary

Dirk Muders
Max-Planck-Institute für Radioastronomie, Auf dem Hügel 69
D-53121 Bonn, Germany, E-Mail: dmuders@mpifr-bonn.mpg.de

April 2, 2007

1 MBFITS Summary Information

1.1 MBFITS History

The MBFITS working group was created at the array receiver meeting at IRAM Grenoble in December 2001. The goal was to define a new raw data format for multibeam receivers based on FITS to be used at the IRAM 30m and APEX 12m mm/submm telescopes. With a common raw data format it is much easier to share software developments in the areas of data calibration (chopper wheel, atmospheric, etc.) and data reduction. The resulting MBFITS format can be used for all single-dish bolometer and heterodyne observations including multiple frontend/backend combinations and array receivers.

1.2 MBFITS and ALMA-TI FITS

The MBFITS format was derived structurally from the ALMA-TI FITS raw data format, although a number of changes had to be made to accommodate the special needs of the IRAM and APEX telescopes. We would like to thank especially Robert Lucas, who is one of the authors of the ALMA-TI format, for his valuable contributions to our discussions.

1.3 Scans, subscans and integrations

The MBFITS format is based on the scan-subscan-integration scheme used by ALMA-TI FITS and retains many of its keywords. However, due to the changes in structure and additional keywords needed to accommodate single-dish configurations, particularly multiple beam observing and multiple frontend/backend combinations, the MBFITS format can now be considered to be an independent format.
Extracted from the ALMA Software Glossary (via ALMA-TI FITS definition, Lucas & Glendenning 2001):

> **dump** The smallest interval of time for which a set of correlated data can be accumulated and output from the correlator.
>
> **integration** A set of dumps, all identical in configuration (except for the antenna motion and some others), that is accumulated and forms the basic recorded unit.
>
> **subscan** A set of integrations while the antennas complete an elemental pattern across the source, possibly while frequency switching, nutator switching, etc. (previous to v.1.54: observation)
>
> **scan** A set of subscans with a common goal, for example, a pointing scan, a focus scan, or an atmospheric amplitude calibration scan, or a correlation scan on a continuum source or a line source.
>
> For instance in the case of holography measurements a subscan would be a drift across the transmitter or a bore-sight measurement, while a scan could be the whole set of subscans needed to acquire a beam map. Or a scan could be a pointing scan with two subscans (an azimuth drift and an elevation drift across the pointing calibrator) or an atmospheric calibration scan with three subscans (autocorrelations on the sky, and two loads at different temperatures, ...).
>
> A scan can be as simple as a short integration on a celestial source while total power and/or correlator output are recorded; or it could be a set of pointed subscans that are used together to form a map of an extended celestial source.

Here are some examples of how this scheme works for single dish observing.
Examples of a scan:

- An on-the-fly map of an astronomical source, including associated sky off subscans
- A raster map ...
- A pointing scan (cross-raster or cross-OTF)
- A focus scan

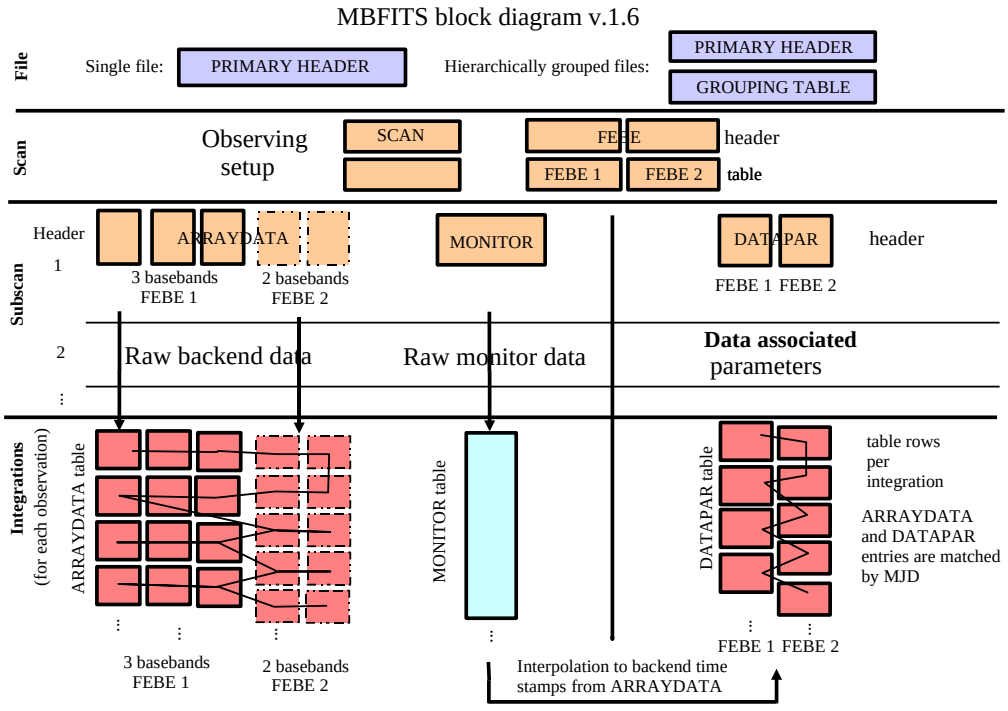

Figure 1: MBFITS file structure

- A skydip
- A flux calibration measurement
- Five on-source measurements forming a cross and a sky off position
- A holography measurement

. . . and a subscan:

- A line of an OTF map
- One sample in a raster
- A sample on a sky off position
- A heterodyne calibration (HOT/COLD/SKY)
- One step in a focus scan

1.4 MBFITS Structure

Figure 1 shows a block diagram of the MBFITS file / directory structure. On each level of time granularity as described in section 1.3 there are one or more FITS binary tables holding the corresponding data. The detailed content and further structural information about MBFITS can be found in the main definition document (APEX report APEX-MPI-ICD-0002, v1.61, D. Muders et al.).